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ABSTRACT

This paper describes the introduction and use of the World Wide Web (WWW) in an elementary science methods course at Florida International University (FIU). The goals of creating a web site include engaging conversations among educators, providing access to local resources for students, and examining student use of web sites and the Internet. The study focuses on undergraduate students with no WWW integration in their science methods course, graduate students with WWW integration, and graduate students with no WWW course integration. The students' frequency of usage, types of usage, and comfort level of using WWW are examined. (Contains 12 references.) (YDS)

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USING A WEB SITE IN AN ELEMENTARY SCIENCE METHODS CLASS: ARE WE OPENING A PANDORA'S BOX?

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Introduction

Since 1989, elementary science faculty at Florida International University (FIU) have worked with both undergraduate and graduate methods students to provide pre-service and in-service teachers with experiences in computer applications to science teaching with such tools as microcomputer-based laboratories (O'Brien, 1991; O'Brien & Peters, 1994) and telecommunications technology.

As a result of our interest in new technologies and their relevance for pre-service elementary teachers, we have been engaged in the construction of a web site and the utilization of web-based resources in our elementary methods courses at FIU. The current growth of the Internet -- which includes the establishment of lesson banks, links to informal and formal science settings, links to organizations that cater to teachers, and especially Internet science projects (see Cohen, 1997) -- makes the Internet an intriguing new gateway to such resources.

While university faculty are increasingly engaged in efforts to use the World Wide Web (WWW), there is as yet little research on the effectiveness of the WWW in the classroom. Technology literature suggests that using the WWW may alter the role of the teacher and the learning process itself (Owston, 1997). For example, Carey (1993) says that the teacher may become more of a facilitator rather than a disseminator of knowledge. The development of the WWW may even herald the replacement of a physical university with a virtual university (Barnard, 1997).

As the WWW increasingly becomes a part of our instruction, a number of questions can be raised about the way it is used including how it differs from other resources such as texts, how

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much prior knowledge is necessary for effective student utilization, and whether it does, indeed, change the way we are teaching.

We have likened the introduction of the WWW in our classrooms to the opening of Pandora's box. If you will recall from the Greek myth, Pandora is given custody of a box as part of her wedding dowry but is admonished not to open it. Driven by curiosity, she eventually succumbs and a variety of demons and evil spirits escape. Finally, there is a knock from the seemingly empty box and Hope appears to allay Pandora's fears and assure her that all is not lost for humankind. Like the myth of Pandora, we have opened up this box (the World Wide Web) we've been entrusted. Some would argue that a number of demons have come out of the opening of this box including access to materials that are confidential or not appropriate for minors. Some already bemoan the the impact of the Internet on the university. For example, in a newspaper editorial, Professor Tom Auxter (Auxter, 1997) opines that the virtual university student is "forced into a passive role, receiving canned materials and sending a reaction into cyberspace". Others look more hopefully at the use of the WWW, and see it as a way to open up new dimensions to learning and resources in a way not previously possible in schools.

As members of the science education community beginning to use the WWW in our own classrooms, we want to share with you some of our experiences in opening this box with our own undergraduate science methods students. We will describe our construction of an Elementary Science web site, a survey of students' use of the WWW at the beginning of the fall semester, 1997, and how we integrated the WWW into our science methods classes this past semester.

Part 1 -Constructing the Elementary Science Education Web Site

The initial development of a web site for pre-service teachers was pursued to investigate the potential benefits and limitations of this purpose. In addition, other reasons for creating a web site are presented.

Why Construct Your Own Web Site When There Are So Many Out There?

Why create a web site when there are so many interesting web sites available in science? For example, the Eisenhower National Clearinghouse (Web address: www.enc.org) has developed a site that caters to the audience of mathematics and science teachers nationally. We believe there are several reasons why it is worthwhile to develop one's own.

Catching The Wave

The growth of the web in recent years has been spectacular. The exponential growth of usage is well known. Recently, some universities such as UCLA have even been requiring that each course have a web page developed for it. The interest in the Internet as a medium provides motivation for its use by students as well as faculty. Increasing numbers of students are arriving in our classes having had experience with multimedia, and are comfortable using the computer medium.

The development of a web site also allows educators to engage in conversation with their colleagues about the value of this medium for the promotion of educational goals.

Locals Too

It may be critical for students to have access to local resources on such a site, both formal and informal. For example, if a student is researching a topic such as the Everglades, not only will a self-created web site with sufficient links and requisite search engines give the student general information about the topic, it could also provide information about contacts (scientists, science museums) in the local area that could give valuable advice about classroom projects.

Is It A Good Medium For Information About Curriculum, Lesson Plans, Etc.?

By taking on the task of creating a site, the instructor also has an opportunity to focus on examining existing sites and weighing their value for potential links.

How Is It Really Being Used?

Still another reason for developing a web site is to allow careful examination of ways in which students are really using the web site and the Internet. Do they spend time using the site in the manner anticipated, or do they use it in a different, more effective manner or do they use it in a way which is contrary to course goals? This issue is described further during a discussion of formative testing in the site development.

Development Processes

Given these reasons, the development of an Elementary Science Education Web Site was begun. In the course of the development, a number of design decisions were made.

Recruiting Site Developers

In order to begin this project, a pair of bright undergraduates who had completed the elementary science methods course the previous semester were recruited. Both students were experienced e-mail users and computer enthusiasts. One had even constructed a rudimentary web site as part of a class project.

Know The Code

Hypertext Markup Language (HTML) was used to create the site. While the growth of web site applications such as Claris Home Page or Netscape Navigagor currently allows the construction of sites without having to write programs, the authors felt that it was important to program in HTML in order to retain flexibilitity in adding features to the site.

Resources

The computer systems available included computer accounts and a UNIX server at the university. The designers worked at their own computers at home, uploading the HTML revisions as necessary.

Exploration - Discovering What Was Of Interest

This process, which is ongoing, is perhaps best characterized at this point as a series of steps.

Step 1- Initial Planning

During the first meetings, initial goals were discussed regarding the audience for the web site. It was decided to focus on researching two aspects of the Internet: desirable elements of site design (by examining a variety of web sites) and science education websites (for content links).

Step 2- Web Site Structure Planning

After the initial meetings and exploration, the designers decided to create a subject-related structure for the first web page prototype. A first page was planned with the subject headings of science subject index, informal science, teacher resources, kids' science, mailbox, and search engines. By selecting the science subject index, six science areas (biology, environmental science, chemistry and physics, earth science, astronomy, and meteorology) were displayed. By selecting one area, the user opens another page displaying in-depth links to that particular subject.

Step 3-First Formative Testing

The designers were anxious to get feedback from the students on the usefulness of the web site before proceeding too much further in the design, so several sessions were conducted to interview students as they utilized the web site. Pre-service student teachers met with the web team during half-hour sessions to review the site. Each was interviewed with respect to his or her experience in using the Internet and purpose for using the site. The students then proceeded to use the site to locate information. In this case, students were intent on gathering information related to preparation of particular science lessons for their teaching assignments. For example, one student teacher (Deborah) was planning a lesson about ants for a group of first grade students. In the course of observing and assisting Deborah's search efforts, the designers noted the levels of help they had to provide and the particular series of steps she took in her search. At that time, few links had been provided to biology sites, so that the student's efforts were redirected to using the search engine links. The student used these to locate a variety of ant-related sites such as E.O.Wilson's Ant Web Site. (Web address: www.dna.affrc.go.jp/htdocs/Ant.WWW/Harvard/ANT_MCZ.html)

Formative Issues

By that point in the development and interview process, a number of issues had been identified concerning the design of the site and the implications of the site for future use.

It was noted that a number of students needed some orientation to the particular browser being used and how to navigate back and forth on the web site itself. This implies that some rudimentary introduction to the use of browsers needed to be conducted, or at least a description of how they work, in order for students to be comfortable using the web site.

The designers found that it would be useful to include descriptors next to the links to indicate what that link contained before users jumped to the link itself.

Finally, it was apparent that pre-service teachers were concerned with locating lessons to utilize. A goal for future work with pre-service teachers was to find ways of addressing this concern within our own framework of critically evaluating such lessons with respect to their hands-on/minds-on relevance.

Part 2-A Survey of Student Usage of the WWW

Web Use Survey

To gather data about how science methods students might be using the WWW before and after the course in which they were expected to use the WWW, a survey was developed and administered at the beginning and end of the semester. (A copy of the survey may be found in the appendix). Elementary methods students' responses were compared to answers given by several other groups of students: undergraduates enrolled in other sections of science methods not attempting to integrate the WWW, graduate students having some course WWW integration, and graduate students having no WWW course integration. We will report here on the results of the pre course survey.

Pre Course Analysis

Prior Use of the WWW

Out of 210 students taking the pre course survey, 57% (119) had previously used the World Wide Web. Interestingly, there was a marked difference in the graduates and

undergraduates experience: Only 39% (15) of the graduate students said that had previously used the WWW, while 60% (104) of the undergraduates had. Thus, undergraduates were more likely to have used the WWW.

Frequency of Usage

Five categories of usage frequency were developed - Non-users (0 times - students who answered that they had not used the WWW were placed in this category), One-time users (indicating they had used it 1-2 times in the last 6 months), Sometime users (indicating they had used it 3-5 times in the last 6 months), Frequent users (indicating they had used it 6-9 times in the last 6 months), and Regular users (indicating they had used it more than 10 times in the last 6 months).

The overall breakdown of each category by level was as follows:

Table 1
Frequency of Usage

	Non-Users	One-time users	Sometime users	Frequent users	Regular users
Everyone	43%	12%	10%	7%	28%
Grads	61%	5%	5%	3%	26%
Undergrads	40%	13%	11%	8%	28%

While both grads and undergraduates had a substantial group of frequent users, undergraduates were more likely to have used the world wide web on one-time or occasional basis. Because there were a substantial number of students who were regular users at both levels, there appears to be a disparity between "haves" and "have-nots".

Types of Usage

Seven categories of types of WWW usage were developed to help create a picture of why students use the WWW do so: 1 - School, 2- Job, 3- Personal, 4- School and Job, 5- School and Personal, 6- Job and Personal, 7 - School, Job, and Personal.

Table 2

Types of Usage

School	Job	Personal	S & J	S & P	J & P	S & J & P
19%	0%	34%	1%	35%	2%	9%

Students indicated that much of their work on the WWW was school related and personal related. Interestingly, very few reported use of the WWW at their job.

Comfort Level

Students indicated their comfort level using the WWW on a five point scale. Scores ranged from 1 (Not at all comfortable) to 5 (Very comfortable). The mean score for all students (N=119) using the WWW was a 3.1 (sd = 1.3), indicating students who had used the WWW upon entering the semester had a medium level of comfort using it.

Differences in Llife or Work

Students were asked if their work, school work, or life was any different since using the WWW. Of the students answering (N=80), 60% (48) said that it was different, many of them mentioning a change in research strategies.

Part 3- Course Integration of the WWW

First Attempt

The Elementary Science Web Site was introduced to an elementary science methods class during the first summer session in 1997. The class was taken to a university computer laboratory where all students had access to computers that had Internet connections. A number of students indicated that they had never used the World Wide Web. Thus students were given a brief

introduction of how the computers were linked to the World Wide Web and how they would be using hyperlinks to "travel" from one site to another. Students were given a "scavenger hunt" assignment to work in teams to find as many sites from a list as possible. These sites included such items as Cockroach world, a science museum, and the Everglades digital library. It was hoped that an introduction in such an atmosphere would encourage students to utilize the web site and demonstrate the ease with which it was possible to "surf the net". In addition, students in this class were also expected to include references to specific WWW sites in their term project.

Fall, 1997

This past fall semester, 1997, we tied the use of the World Wide Web to course objectives in several ways. These included an introduction to the elementary education science web site, use of the GLOBE web site, use of a class web site, use of science standards web sites, and identification of web site resources as part of investigation assignments. As an illustration of our early attempts to integrate the WWW, course uses of the WWW by one of the instructors will be described in this section in some detail.

Introduction to the Elementary Science Web Site

Like the students in the first summer session, students were introduced to the Elementary Science Web Site on the first day of class and asked to conduct a scavenger hunt.

GLOBE Site Usage

One of us had the opportunity to take part in a GLOBE training session last summer. GLOBE is a program sponsored by NOAA and NSF to utilize a variety of protocols developed by scientists for use with K-12 schools which gather data and enter it into a database via web site. Participating schools are located in a number of countries and at numerous locations in the USA. The web site (Web address: www.globe.gov) contains tools such as graphs that allow the data to be displayed in various forms. Anyone using the WWW can enter the web site and view the data using the interfaces provided. Thus the GLOBE site provides an opportunity for student teachers to become acquainted with data gathering and analysis features. The GLOBE site provides a number of databases several of which (temperature, precipitation, cloud cover, and

cloud type) related to our theme of studying patterns of weather. As another opportunity for students to utilize the WWW, students spent part of one class period in the computer lab looking at the GLOBE web site. Students were introduced to the web site and shown how to create graphs with selected data using the graphing interface. They were then given an assignment to display weather data from the GLOBE site using a variety of countries or locations. For example, they could have compared temperature at sites on the five continents for January through September, 1997. Students were expected to display their findings in hard copy form and discuss any patterns they found.

Course Web Page

A simple course web page (Web address: www.fiu.edu/~lewiss/weath.fall.97.htm) was developed using Netscape Navigator- Gold version. It included links to the elementary science page, lecture notes, and updated links to topical weather events such as El Niño and relevant weekly topics. Students were encouraged to search for information on these topics via the elementary science web site or a web search engine such as Yahoo, and then create the appropriate links to the class web site. They were also reminded by e-mail to check on the web site periodically to note updated links and information. For example, to supplement a discussion about the nature of science and the ways that new theories enter the accepted arena of science (See Duschl, 1990 for an extended description of this process), a web site was located (Web address: csep10.phys.utk.edu/astr161/lect/comets/smallcomets.html) discussing the new theory that small, water-laden comets are entering the atmosphere at a rate that may explain the development of the oceans. The site also contains an interesting description of the process by which the theory was developed. Thus students who viewed this site were able to get current information about the theory and its development via the World Wide Web.

Science Standards

Another goal of the course was to have the students become familiar with the National Science Standards and Florida Sunshine Standards in science. Using a web page developed for searching the Sunshine Standards (Web address: http://intech2000.miamisci.org/sss/sc/), students

were required to locate the Sunshine Standards that pertained to their weather topic of study. The downloaded standards were then compared to the relevant National Standards.

Identification of Web Site Resources

A final project utilizing the Web had to do with one of the students' group projects. Students were required to pick a topic having to do with patterns of weather such as patterns of hurricane development. They then did extensive research in order to understand how the topic related to education. As part of this research, students were required to list at least two WWW addresses (URLs) that pertained to the topic.

Student Input into the Course Web Page

Students were not actively solicited to contribute to the web page, but two of them made contributions that led to the extension of the development of the web page. The first contribution was made indirectly by Susan, who had made a beautiful photographic collection of clouds. (Web address: www.fiu.edu/~lewiss/clouds1.jpg). After viewing these in class, it was suggested to her that the photos be digitized and that we could add these to the course web site. She had a friend scan them and digitize them, so we were able to incorporate these into the course web site.

The second student, Sean, found a science lesson web site (Web address: www.csun.edu/~vceed009/lesson.html) and reported this via e-mail. The site was examined and found to contain a variety of activities, a number of which had already been identified as consistent with the constructivist approach that guides the course.

As part of the class, students were to have an opportunity to examine lessons and to analyze them in various ways such as their relationship to the National Science Standards. The use of a digital bank of lessons offered an interesting way for students to find lessons to analyze which might also encourage them to use this source in the future. Therefore the lesson web site was added as a link to the course web page, and students were required to download a lesson for analysis. The development and utilization of science lesson banks on the Web is an area that bears further examination beyond the scope of this presentation.

As described, students had a number of in-class opportunities to use the WWW and several assignments that required them to use it outside of class.

PART 4-General Issues to Be Explored

These initial findings from the survey and observations from the early course use of the web sites raise several general issues about using the WWW in science methods courses.

Accessibility

A major issue is whether students can get sufficient access using the WWW. We have already seen from data on the pre-course survey that a large group of students are regular WWW users, while another large group never uses it. There have been recent developments that make it somewhat easier for Education students at FIU to access the Web through the addition of a computer lab with high speed Internet connections. In addition, a growing number of students have computers available at home or work. Nevertheless, many students may not be able to afford the computer hardware needed to successfully use the WWW. In addition, the university does not currently provide undergraduates with their own PPP accounts that allow WWW access via modem. Thus, unless students have sufficient computer hardware and software at home and their own Internet provider, using the WWW can be problematic and may lead to further disparities between the "haves" and "have nots".

Navigation Issues

Some students expressed difficulties in their understanding of how to navigate the WWW; they sometimes got lost. As Hill and Hannafin (1996) found, students who are disoriented in such an environment may not use optimal search strategies to locate relevant materials. Students were observed making ineffective searches or not carefully thinking about alternative ways of locating information through different types of searches. These students required a great deal of instructor assistance, a finding supported by Lyons et al (1996) who worked with middle and high school students using the WWW.

Additionally, the dynamic nature of links (which often change or are not accessible due to heavy traffic or servers being down) can sometimes make it frustrating to use. Students sometimes decided to use their own computers during off hours rather than wait for access.

The Dis-Information Age

While the number of sites and growth of the net are astounding, general questions are being raised regarding the quality and accuracy of the information available. Recent pranks involving the display of pseudo-data underscore the ease with which misinformation can be generated. This same issue surfaces with respect to the resources available for science education: how do we assess the quality of the information we are finding?

Inaccurate information also may be incorporated into the lesson that the pre-service student finds on the WWW. Similarly, the philosophical orientation of the lessons themselves -- which may be less than desirable from our own orientation -- may be hidden from the inexperienced teacher who is focused on creating some activity. Thus, there is a need to acquire a disciplined approach in facing the overwhelming sea of information available via the WWW. (Ryder & Wilson, 1996)

Accordingly, it may be important to promote the adoption of a critical framework for analyzing Web information like that suggested by Ryder & Hughes (1997). Their framework, which has been adapted from criticism of literary resources, addresses the following five points:

1. The purpose and audience (what is the intent of the information and why it is being communicated?)
2. Authority (What are the credentials of the individual(s) or group(s) presenting this information?)
3. Scope (What is the breadth, detail of the information provided?)
4. Format (How is this information presented? Can it easily be interpreted? Can it readily be acquired or reproduced?)
5. Acceptance of material (What is the opinion that others have of this material?)

The Uniqueness of Science Resources on the Internet

While there are a number of drawbacks in using the WWW, the use of the Internet provides unique opportunities for scientific study as described in the GLOBE project. Data sets

are available for students to utilize in authentic studies. For example, students can access pictures from weather satellites and make their own forecasts. Scientists themselves can be engaged for discussion and advice. Students can rapidly find information about scientific developments.

Further Steps

We see the integration of the WWW in our science methods courses as a continuing cycle of experimentation and research. The post course survey will be analyzed with respect to changes in student use of and attitude toward the WWW. This should help shape further integration of the WWW in the science methods course, and lead to additional rounds of analysis and course development.

As K-12 and community use of the Internet expand, and as we move toward more use of the WWW in our post secondary science methods courses, the exploration of these benefits and drawbacks will become an increasingly important agenda item for the science education research community.

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Student Survey (Pre-Course)

Dear student,

We are surveying student use of the World Wide Web for information purposes as a follow-up to the first survey. Your answers will not affect your grade. Please provide the following information on both pages:

Student Name _____ Date_____Course_____

1. Have you used the World Wide Web?

Yes No

If you answer "No" to this question, please stop and turn in your survey, otherwise continue to answer the following questions:

2. How many times have you used it in the last 6 months?

1-2 3-5 6-9 More than 10 but not regularly Regularly

3. What do you use it for?

School work On the job Personal (including entertainment)

4. How comfortable are you using the World Wide Web?

Not at all comfortable Somewhat comfortable Medium medium comfortable Somewhat more than comfortable Very comfortable

5. Describe in detail how you are using it (especially in this or other classes).

6. Since you have started using the World Wide Web, is your work, school work, or life any different than before you started using it? Please describe why or why not in detail. (Use the back if necessary)

Post course survey additional questions below:

7. If you have been using the World Wide Web in this class or other classes this semester, has your attitude toward it changed? Circle one: Yes No

If yes, please describe how it has changed and why it has; if no, why not.

8. Any other comments you have on using the World Wide Web.

Thank you for your help in completing this survey!